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PRINT DATE:

**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL HARDWARE
NUMBER: P2-3A-A4 -X**

SUBSYSTEM NAME: SEPARATION MECHANISMS - PYRO

REVISION: 1 03/27/95

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	AFT ATTACH FRANGIBLE NUT	SKD26100099-302

PART DATA

**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
AFT ATTACH FRANGIBLE NUT**

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 2

FUNCTION:

IN CONJUNCTION WITH A BOLT, STRUCTURALLY TIES TOGETHER THE ORBITER/
EXTERNAL TANK (ET) AT TWO AFT ATTACH POINTS. FRACTURES UPON RECEIVING A
SHOCK OUTPUT FROM EITHER OR BOTH DETONATOR/BOOSTER CHARGES.

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL FAILURE MODE
NUMBER: P2-3A-A4 - 02

REVISION# 1 03/27/95

SUBSYSTEM NAME: SEPARATION MECHANISMS - PYRO

LRU: AFT ATTACH FRANGIBLE NUT

ITEM NAME: AFT ATTACH FRANGIBLE NUT

CRITICALITY OF THIS
FAILURE MODE: 1/1

FAILURE MODE:
FAILS TO FRACTURE

MISSION PHASE:
LO LIFT-OFF

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

102	COLUMBIA
103	DISCOVERY
104	ATLANTIS
105	ENDEAVOUR

CAUSE:
INADEQUATE SHOCK OUTPUT FROM DUAL DETONATOR/BOOSTER CHARGES.
IMPROPER MACHINING OF FRANGIBLE WEB, OVER-STRENGTH MATERIAL

CRITICALITY 1/1 DURING INTACT ABORT ONLY? YES
LO LIFT-OFF

REDUNDANCY SCREEN

A) N/A
B) N/A
C) N/A

PASS/FAIL RATIONALE:

A)

B)

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:
LOSS OF SEPARATION CAPABILITY AT ORBITER/ET AFT ATTACH POINT.

(B) INTERFACING SUBSYSTEM(S):
ET REMAINS STRUCTURALLY ATTACHED AT AFT ATTACH POINT.

(C) MISSION:
POSSIBLE LOSS OF MISSION.

(D) CREW, VEHICLE, AND ELEMENT(S):
POSSIBLE LOSS OF CREW/VEHICLE.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL FAILURE MODE
NUMBER: P2-3A-A4 - 02**

(E) FUNCTIONAL CRITICALITY EFFECTS:

-DISPOSITION RATIONALE-

(A) DESIGN:

CAPABILITY OF SINGLE DETONATOR/BOOSTER CHARGE TO FRACTURE 115% OF WEB THICKNESS. NUT MATERIAL IS INCONEL 718 FOR CORROSION PROTECTION.

THE -302 NUT IS SIMILAR TO THE -301. THE -302 NUT HAS CHAMFERED OUTER EDGES AT BOOSTER CARTRIDGE PORTS. THE CHAMFERED EDGES ENHANCE HINGING CAPABILITY FOR WEB SEPARATION, ESPECIALLY FOR SINGLE CARTRIDGE FIRING.

(B) TEST:

COMPONENT QUALIFICATION TESTS OF -301 NUT: SALT FOG, VIBRATION W/HIGH/LOW TEMPERATURE, HIGH TEMPERATURE FIRING AT ALTITUDE, FIRING AT LOW TEMPERATURE WITH AXIAL LIMIT LOAD, ROOM TEMPERATURE-ZERO LOAD FIRING, SINGLE BOOSTER 120% WEB MARGIN DEMONSTRATION, -65 DEG F/AMBIENT/+200 DEG F SINGLE AND DUAL FIRINGS, LIMIT AND ULTIMATE STRUCTURAL LOAD TEST WITH BENDING MOMENT. CERTIFICATION REQUIREMENTS (CR) 45-114-0018-0007.

COMPONENT DELTA QUALIFICATION TESTS OF -302 NUT: TEN SINGLE CARTRIDGE FIRING TESTS WITH 270,000 LB. PRELOAD AND ZERO PRELOAD, INCLUDING THREE MARGIN DEMONSTRATION TESTS WITH 115% WEB THICKNESS. ONE DUAL CARTRIDGE FIRING TEST WITH 270,000 LB. PRELOAD. CR NO. EP-A-1-26100099-302.

SYSTEM QUALIFICATION TESTS OF -301 NUT: 8 SEPARATION SYSTEM FIRINGS, AMBIENT, PRE-LOADED TO FLIGHT CONDITION, STRUCTURAL LOAD TESTS TO LIMIT, LIMIT WITH JOINT TORQUE 2 DEGREES, AND 1.4 LIMIT. CR45-565201-001.

ACCEPTANCE TESTS: 100% HARDNESS, 100% LOT TESTED TO LIMIT PROOF LOAD WITH NO THREAD OR WEB DEFORMATION, LOT SAMPLE FIRINGS, LIMIT AND ULTIMATE LOAD (FAILURE REJECTS LOT), 100% DYE PENETRANT. LIMIT LOAD UNITS ARE ACCEPTANCE TEST FIRED WITH SINGLE DETONATOR/BOOSTER CHARGE. FAILURE TO FRACTURE IS CAUSE FOR REJECTION OF LOT. MATERIAL INTEGRITY VERIFIED BY TENSILE TEST COUPONS. CR45-114-0018-0007, ATP 8645; SKD26100099.

OMRSD: TURNAROUND TESTS INCLUDE - AFT ATTACH NUT/STUD FIT, THREAD CHECK, AND VERIFICATION OF ALL PARTS OF SEPARATION SYSTEM IN DEBRIS CONTAINERS. NEW HARDWARE INSTALLED EACH FLIGHT.

(C) INSPECTION:

RECEIVING INSPECTION

RAW MATERIAL IS VERIFIED BY INSPECTION TO ASSURE SPECIFIC SHUTTLE REQUIREMENTS ARE SATISFIED.

CONTAMINATION CONTROL

CONTAMINATION CONTROL AND CORROSION PROTECTION PROCESSES ARE MONITORED AND VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

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SELECTED MANUFACTURING/ASSEMBLY STEPS ARE IDENTIFIED BY NASA AND QUALITY ASSURANCE AND VERIFIED BY GOVERNMENT INSPECTION MANDATORY INSPECTION POINTS (MIPS).

NONDESTRUCTIVE EVALUATION

100% DIMENSIONAL VERIFICATION OF WEB THICKNESS. DYE PENETRANT AFTER PROOF LOAD.

CRITICAL PROCESSES

ALL MANUFACTURING PROCESSES SUCH AS PLATING, HEAT TREATING, AND PASSIVATION ARE VERIFIED BY INSPECTION.

TESTING

DESTRUCTIVE LOT ACCEPTANCE TESTING BY SAMPLE SIZE VERSUS LOT SIZE.

STORAGE

STORAGE ENVIRONMENTS ARE MONITORED AND VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:

-302 FRANGIBLE NUT FAILED TO SEPARATE IN DESTRUCTIVE LOT ACCEPTANCE FIRING TEST USING SINGLE DETONATOR AND BOOSTER CARTRIDGE, P/N SKD26100099-401. NEW BOOSTER CARTRIDGE, P/N SKD26100099-402, PROVIDES GREATER ENERGY FOR FRANGIBLE NUT SEPARATION, AND RESTORES SINGLE CARTRIDGE/NUT SEPARATION MARGIN. DLAT FAILURE WAS ATTRIBUTED TO NEW LOT OF -302 FRANGIBLE NUTS WITH HIGHER STRENGTH PROPERTIES, REF. FIAR NO. JSCEP0183.

(E) OPERATIONAL USE:

NONE.

- APPROVALS -

PAE MANAGER : K. L. PRESTON
DESIGN ENGINEERING : P. YSON
PRODUCT ASSURANCE ENGR : D. MAYNE
NASA SSMA :
NASA SUBSYSTEM MANAGER :

Atell
: *Paul Olson 3-29-95*
: *D.M. Maine 3-27-95*
: *Jeff Borkman 5-2-95*
: *William C. Hoffman 5/2/95*